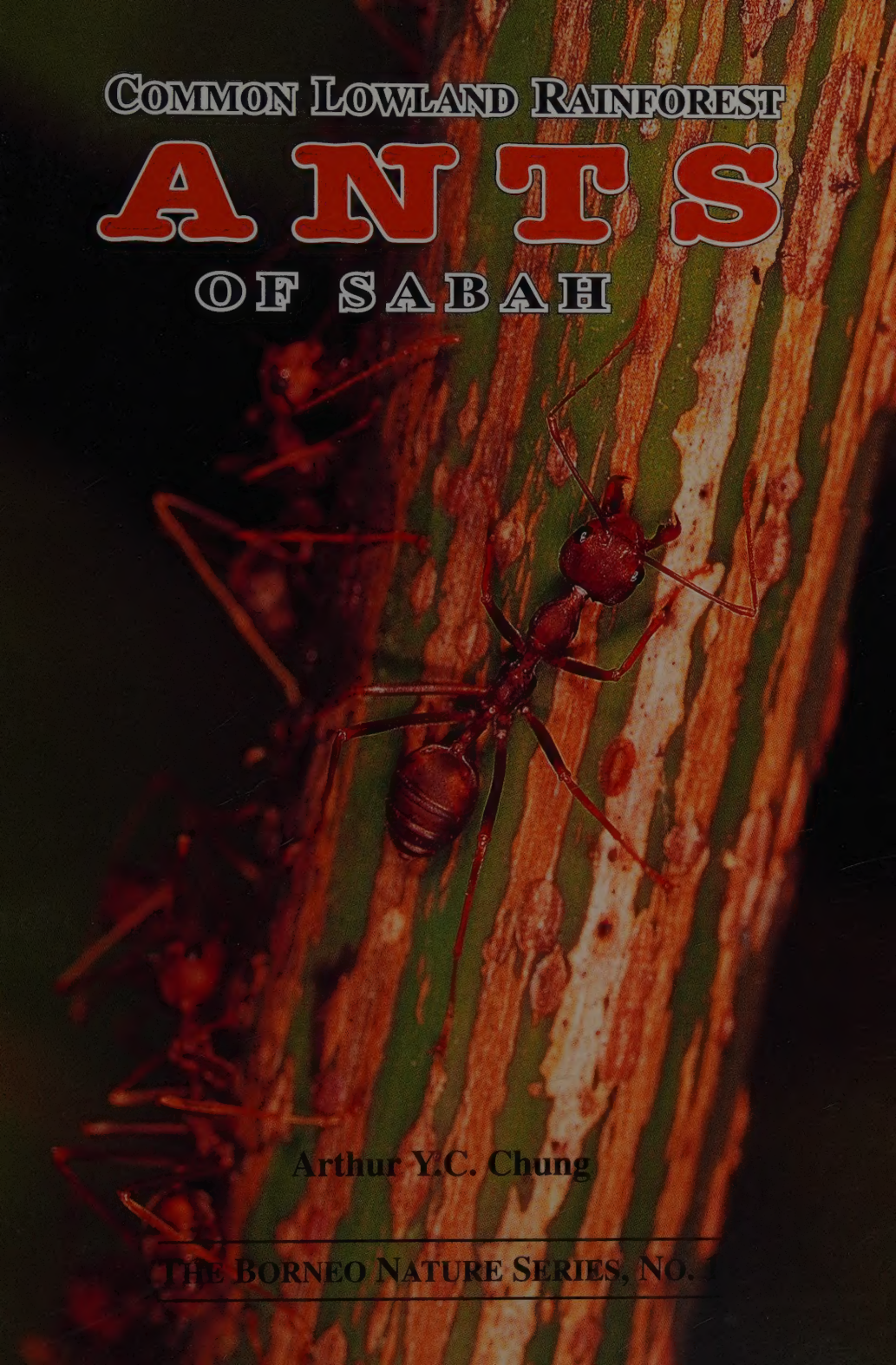
COMMON LOWLAND RAINFOREST

ANTS

OF SABAH



Arthur Y.C. Chung

THE BORNEO NATURE SERIES, NO. 1

COMMON LOWLAND RAINFOREST ANTS OF SABAH is a simply written account that tells of the fascination of these tiny creatures. It is an introduction to the biology and interesting habits of ants, and how they are classified. Brief notes on Borneo's and Sabah's more common or unique ant species bring the reader into the world of ants, which are an ecologically significant part of our living heritage.

Front cover photograph:

The Common Weaver Ant
(Oecophylla smaragdina).

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Arthur Y.C. Chung
with illustrations by the author

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Forestry Department, Sabah

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Common Lowland Rainforest Ants of Sabah

by Arthur Y.C. Chung

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The neglect of ants in science and natural history
is a shortcoming that should be remedied,
for they represent the culmination of insect evolution,
in the same sense that human beings represent
the summit of vertebrate evolution.

B. Hölldobler & E.O. Wilson,
in "The Ants" (1990).

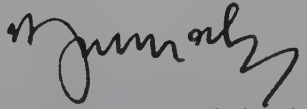
CONTENTS

FOREWORD

Mention of the rain forest conjures up a mental image primarily dominated by the lushness of plant life. For some of us, the large mammals and rainforest birds, and reptiles such as snakes and geckos, add a special dimension of excitement. But the amazing component of invertebrates, in particular the insects, play an equally significant role.

The biology of the forest, influencing practically every field of forestry including its components of conservation, silviculture and pest and pollinator ecology, needs to be approached from two major plans. While ecological studies of forest stands provide a system approach, we also require studies and documentation of individual biotic groups. From the viewpoint of forest functioning, the small insects have also to be better understood.

Ant biology, or for that matter, insect biology in general, suffers the same documentational problems as for other highly diverse groups of tropical plants and animals: there are too few workers, and an incredible number of species. This book is an introductory account, and will serve to prepare the ground for those who are keen in knowing more about the variety of insect life of our forests. We are indeed fortunate that the long hours of studying ants, their ecology and behaviour in the forest are now translated into a form that is both informative and accessible to general readership.



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Malaysia.

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I am greatly indebted to Dr Maryati Mohamed of the Universiti Kebangsaan Malaysia for introducing me to the magnificent world of the ants. The production of this account would not have been possible without the support and encouragement of many people. In particular, I would like to thank Dr K.M. Wong of the Forest Research Centre, Sepilok, for encouraging me; his constructive suggestions and editorial skills have been of immense value. I am grateful to Haji Awang Tengah Hj. Ag. Amin, the Director of the Sabah Forestry Department for his support in my continuing studies of ants. Y.F. Lee, Robert C. Ong and Anuar Mohammad, past and present heads of research at the Forest Research Centre, Sepilok, and Dr V.K. Chey have given much encouragement to my work.

My continuing work on ants was spurred on after a one-year study in the Danum Valley Conservation Area in Sabah. That study, which was part of an M.Sc. project funded by the Sabah Shell, with the support of Malaysian Government IRPA (Intensified Research in Priority Areas) funds, and the Royal Society, U.K., has been an inspiring experience for me. I am grateful to Dr Clive Marsh of the Innoprise Corporation and Dr Maryati for helping to secure that opportunity for me. It was a special period spent at the Danum, and I thank also my friends there for their hospitality and assistance. I am also grateful to C.L. Chan for advice on points of photography. Thanks are also due to Prof. U. Maschwitz of the J.W.-Goethe University, Frankfurt, Germany, for identifying specimens of Drummer Ants.

Last but not least, I wish to express my thanks to Kit Yee for her friendship and support. I am also grateful to the Entomology staff (S. Lantoh, M. Binti, M. Allai, W. Jimin, and R. Lusiansis) for their assistance in preparing this account. The manuscript was typed by C. Lapongan and V.L. Pung, of the Forest Research Centre, Sepilok, Sandakan.

THE ANT WORLD

Most people are familiar with ants because they are found almost everywhere, but not many people know much about these tiny living creatures. To many of us, ants are pests or a nuisance with no significant value in any field. To a certain extent, it is true that some ants are pests, such as in homes or as seed harvesters, and some protect sap-sucking insects which are themselves pests. Some ants inflict stings and bites. It is very difficult to appreciate the wonder of ants because they are small and many superficially alike, unlike butterflies, which are attractive and colourful. However, ants are quite unique in their social organisation and behaviour.

Ants are called *semut* in Malay and *kilau* in Kadazan. The industrious character of ants has inspired such popular phrases as "*rajin seperti semut*" (in Malay: as hardworking as an ant). The numerous local names given to ants reflect the diversity of ants in morphological and behavioural terms, such as *semut api* ("fire ants"), *semut gajah* ("elephant/giant ants"), *semut gula* ("sugar ants") and *kerengga* ("weaver ants").

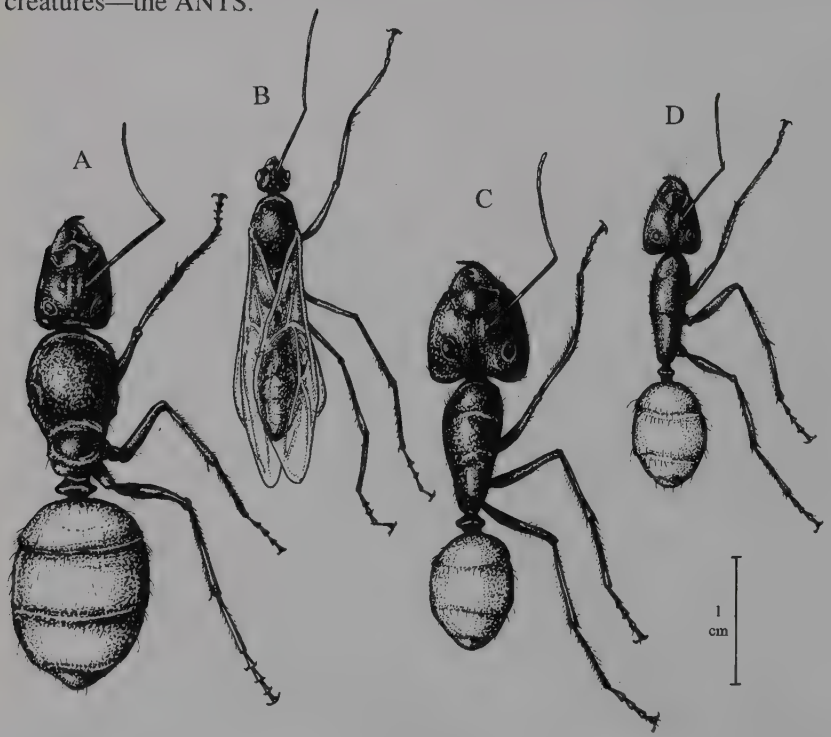
If one looks closely at the ground level of a tropical rain forest, it can be seen how one group of creatures can change the environment. Tiny trails and mounds are evidence of the engineering skills of the largest group of insects in the tropics, the ants. Thousands of them crawl in monotonous processions along the forest floor. Ants are in fact everywhere, on the ground, on plants, on tree trunks, fruits, flowers and branches. But the variety on the forest floor is particularly evident. Ants come in different colours—red, black and brown—and in different sizes. Some sting, some bite, some eat foliage, and some eat other insects.

Being one of the most abundant and diverse insect groups in the tropical rain forest ecosystem, ants are ecologically important. They play important roles in decomposing organic matter, nutrient cycling and soil enrichment. Ants are also a food source for other organisms, such as reptiles, birds and mammals. They can control parasitism and predation, and some ants even exhibit mutualistic relationships with plants. Ants are also seed dispersal agents. Despite their importance, the biology of

Malaysian ants is poorly documented. A 1990 estimate by Hölldobler and Wilson says that it is possible some 20,000 species of ants exist in the world, represented by as many as 350 genera.

Sabah, at the northern tip of Borneo island, and between latitudes 4° 8' and 7° 22' north of the equator, has a land area of some 7.37 million hectares. Called the "Land Below the Wind", it has an equatorial climate with high rainfall (1700–5100 mm per annum).

The primary aim of this guide is to enable nature lovers to appreciate the beauty and importance of some ants in the lowland tropical rain forests of Sabah. As the local ants are so numerous, only a selection of the common or interesting species are dealt with here. It is my hope that this booklet may prove interesting reading to people from different walks of life, and the information and illustrations presented here will stimulate more people to take an interest in the beauty of these tiny living creatures—the ANTS.



Different castes of the Giant Forest Ant, Camponotus gigas: *A, queen with its wings shed off; B, male; C, soldier; D, worker.*

The Social Organisation And Behaviour Of Ants

Ants are eusosial (true social) insects, belonging to a single family, the Formicidae, within the order Hymenoptera, which includes the bees, wasps, ichneumons and other similar forms. Although termites or "white ants" are fully social in organisation as well, they are totally different from ants morphologically and genetically. Termites belong to the order Isoptera, which appear to have been evolved from cockroaches, whereas ants are akin to wasps. Termites undergo partial metamorphosis but ants exhibit a complete metamorphosis. The term metamorphosis is applied to the change from larval to adult stages, which involves a number of transitional forms.

The social organisation of ants is divided into different castes, typically consisting of one or more *queens* (reproductive females), a small number of *males* and mostly *workers* (neuter females). In some species, there are also intermediate castes which are also neuter females but with enlarged heads, known as *soldiers*. Species that have a continuous range of worker forms, from minors through to majors (e.g., soldier castes) are said to be polymorphic, while those that have all workers identical or nearly so, are monomorphic species. All ants live in colonies and every caste in the colony has its own specialised task.

Wings are only confined to the virgin queens and males. After the nuptial (mating) flight, the queen which has been inseminated by one or more males will shed her wings and begin to roam around on the ground to find a suitable place for a new colony. For this purpose, she uses the energy stored inside the flight muscles at the back of the bulky thorax, just behind the head. Normally, the queen will excavate a small chamber in the soil or a fallen log, where she lays her first batch of eggs. The eggs hatch into whitish or yellowish larvae. The larvae will eventually pupate, often after spinning cocoons, and finally emerge as adults. The queen will continue to lay eggs, now with the care of the worker caste. In general, the queen only mates once but she has an incredible pouch which can store a large number of sperm cells. After producing a few generations of worker ants, the queen will have enough workers to supply her with sufficient food.

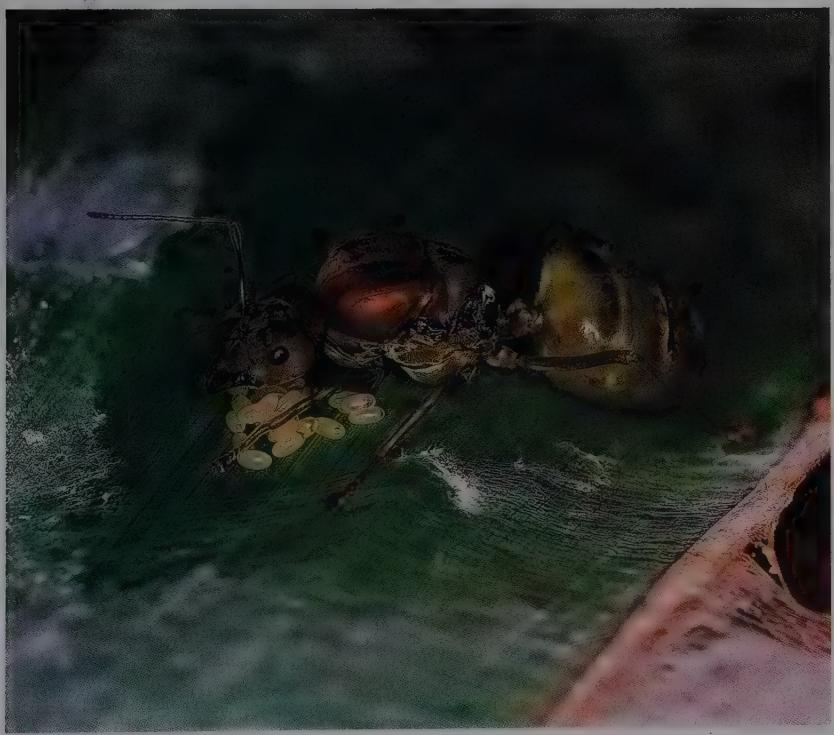
This is part of the nuptial flight and mating process. The flying ants (males and queens) are attracted to light at night. In species with large populations, it is not uncommon for one colony to release hundreds or thousands of the young winged males and queens at one time. Many males would pursue a virgin queen after she has landed on the ground.

Eventually, she will gain momentum to produce a fertile generation, and so the "cycle" goes on and on. The queen has the longest life span. It has been reported that a queen can live for more than 10 years. The males will die shortly after the nuptial flight, their only task being to mate with the queen; they have no further role in the colony's life.

Worker ants are unable to reproduce but function to carry out their daily task for the well being of the colony. They forage for food and take care of the queen and her brood. The soldier ants perform different tasks in different species. Some of them accompany the foraging worker ants, protecting the colony from being attacked by intruders. Some stand

guard at the entrance of the nest, acting as doorkeepers, whereas others have formidable mandibles to crush tough or large bits of food so that the workers can carry these back to the nest.

Division of labour, with each caste working at its specialised task, is innate among ants, and contributes to the systematic functioning of the colony as a whole. This wonderful behaviour is often observed when the ants are carrying a large quantity of bulky and heavy food back to their nests. Not only that, they also seem to be clever creatures; on a few occasions, when the food is too big to enter the nest entrance, the ants will cut it to pieces, so that it can be brought into the nest. In times of danger, especially when the nest is being disturbed or attacked by predators or other ant species, the soldier caste will fight and defend



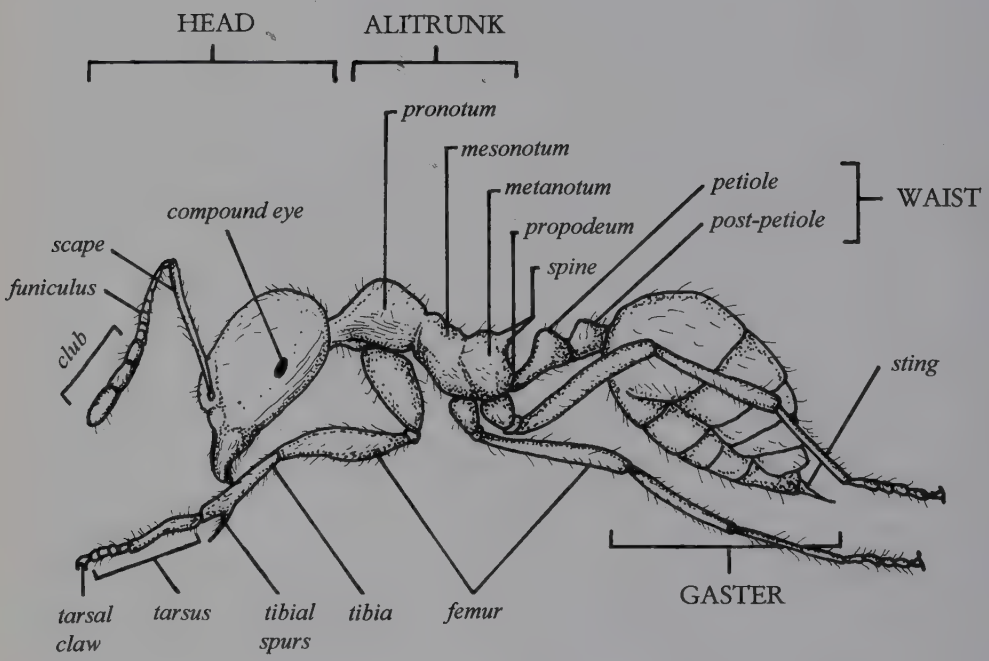
The queen of Oecophylla smaragdina, *guarding the newly laid eggs. The nursing of the first generation of the new colony is solely dependent on the queen. Workers of the first generation then assist the queen in nursing later broods.*

The "kissing" behaviour, commonly seen among ants that meet. Some ants, such as Oecophylla smaragdina, *communicate through antenna movement, besides secreting pheromones.*

their territory. At the same time, the worker caste will take care of the queen and her brood. Some workers will carry the pupae and larvae in their mandibles while others surround the queens and escort them to safer places.

Ants communicate mainly through chemical communication. Pheromones are used in chemical communication. Trail pheromones are volatile substances which are released when the ants are foraging for food. There are also alarm and mating pheromones. Ants can detect the release of pheromones easily because they have a lot of chemical receptors on the antennas and also other parts of their bodies. When the alarm pheromones are released, the ants will act aggressively; the mandibles and antennas will be widely opened. In the case of formicine ants, the gaster will be lifted, ready to secrete formic acid, which causes irritation to their predators.

Ants also communicate with their antennas. They are often seen "kissing" each other when they meet along the trail, with their antennas moving from side to side or forward and backward. The movement of antennas shows the location of food or nest site. The "kissing" behaviour is also observed during trophallaxis. Trophallaxis is the exchange of alimentary liquid among colony members and guest organisms, either mutually or unilaterally. The workers of most species belonging to the phylogenetically more advanced subfamilies Myrmicinae, Dolichoderinae and Formicinae, engage in trophallaxis.



The different parts of an ant, shown here with the worker of a species of Pheidole, *a myrmicine ant.*

Ant Morphology And How They Are Classified

Like that of other insects, the body of an ant is basically made up of a head, a middle portion called a thorax and an abdomen. However, in an ant, the first abdominal segment (the propodeum) is fused to the thorax and the whole part is called an alitrunk. The second abdominal segment (and in certain ants, the third abdominal segment as well) forms a waist which connects the alitrunk and the remaining abdominal portion. The segmented waist is made up of the petiole (2nd segment) and post-petiole (3rd segment). The gaster, which most people confuse with the entire abdomen, is thus only a part of the whole structure. Ants have geniculate (elbow-shaped) antennas which consist of the scape and funiculus. The antennas and the segmented waist are the distinctive features in ants which distingush them from other insects.

Seven of the eight subfamilies enumerated for the Oriental region (with reference to Bolton's key in Hölldobler and Wilson, 1990) are found in Sabah's lowland rain forests. The most abundant and diverse group is the Myrmicinae subfamily, followed by the Formicinae and Ponerinae. The Dolichoderinae and Dorylinae are rather moderate in terms of number of species and abundance. Fewer species are recorded for the Pseudomyrmecinae (*Tetraponera* spp.) and Leptanillinae. However, the subfamily Leptanillinae will not be discussed here, as it is rarely encountered.

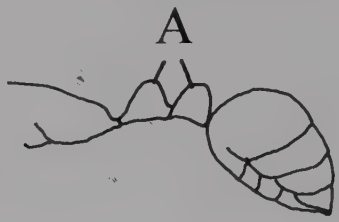
The taxonomy of ants is a difficult and involving subject, and as yet little studied. However, the different subfamilies are distinctive and, with some experience, can be easily recognised.

Ant taxonomy. The main characters used to differentiate the major subfamilies are the presence or absence of a post-petiole and the structure through which defensive fluids are discharged at the apex of the gaster: via a sting (Myrmicinae, Ponerinae, Dorylinae and Pseudomyrmecinae), through a small cone with a circular opening (Formicinae), or through an obscure slit (Dolichoderinae).

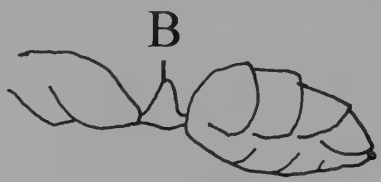
In the following pictorial key to identifying the six subfamilies commonly encountered, each number pair of statements contains contrasting characters. The correct characteristics should be selected, leading to a next pair of statements, or to the identity of the subfamily.

Key to ant subfamilies in Sabah's lowland rain forests

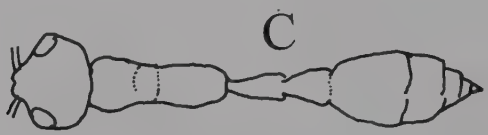
1. Waist two-segmented (A); sting present though not necessarily visible 2



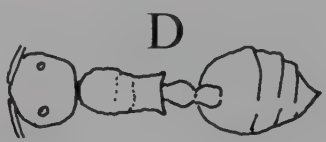
Waist one-segmented (B); sting present or absent 3



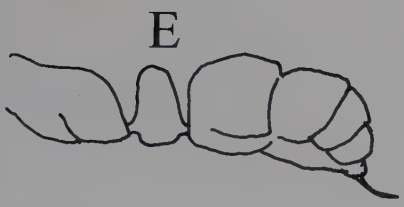
2. Body elongated or slender (C), length exceeding 5 mm .... **PSEUDOMYRMECINAE**



Body not elongated or slender (D), length usually less than 5 mm .... **MYRMICINAE**

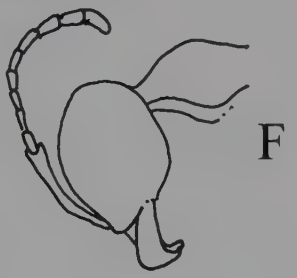


3. Sting present though not necessarily visible; gaster usually with a prominent constriction between the first and second segments; petiole often broad in profile and not scale-like (E) .... **PONERINAE**



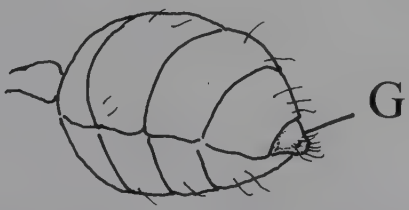
Characters not as above 4

4. Eyes absent or inconspicuous (F) ..... **DORYLINAE**



Eyes present 5

5. Small cone present at the apex of the gaster (G), with a circular opening as a nozzle, serving as an acid-projecting system .... **FORMICINAE**



Cone absent and replaced by an obscure slit (H) present at the apex of the gaster (gaster normally with a distinctive odour when crushed) ..... **DOLICHODERINAE**

ANT COMMUNITIES IN THE RAIN FOREST

The ant fauna is very abundant and diverse in the tropical rain forest. Due to this, different species sometimes nest and forage in different parts of the forest and also at different times. In general, ant habitats in the rain forest can be divided into three levels, arboreal, epigaeic and subterranean. Arboreal ants forage predominantly on the vegetation, epigaeic ants forage predominantly on the ground, while subterranean species are found exclusively in the soil and leaf litter.

Arboreal ants. Many arboreal ants are fairly large, such as the Giant Forest Ant (*Camponotus gigas*) and the Spiky and Golden Ants (*Polyrhachis* spp.). The arboreal ants feed mainly on the extrafloral nectaries and food bodies on plants. Extrafloral nectaries are sugary secretions, produced from the secretory organs which possibly contain amino acids, attractive to ants and other insects. Food bodies are special nutritive corpuscles evolved by certain plants to attract ants. Many of the arboreal ant species exhibit mutualistic relationships with plants. Besides

(opposite)
Arboreal (1, 2 and 3), epigaeic (4) and subterranean (5) ant communities in the rain forest. (1) is a "cut away" view showing multiple chambers inside a Crematogaster *nest built on a tree branch. (2) shows a young* Macaranga hypoleuca *plant with swollen parts of the stem within which are spaces suitable as nest sites for ants. (3) reveals branch hollows of the shrub* Myrmeconauclea strigosa, *which are ant-inhabited. (4) is a "cut away" view of a rotting log, showing a colony of* Pheidole *species. (5) shows* Strumigenys *ants found exclusively in the soil.*

food, some plants provide shelter for ants. Ants can live in the cavities of tree trunks and swollen spaces within branches. Pioneer trees of the genus *Macaranga* (of the Euphorbiaceae or Rubber-tree family) are often seen associated with small myrmicine ants (*Crematogaster* spp.). These ants feed mainly on food bodies provided by the plants and have their colonies inside the hollow branch segments. In return, the ants protect their host trees against vine growth (by biting off clinging parts) and herbivores (by attacking animal visitors).

Another plant which is inhabited by ants is the common stream-side shrub *Myrmeconauclea strigosa*, commonly found along lowland rain forest streams in Sabah. This shrub, only about a metre high and is much branched, with numerous hollowed branch segments which are specialised structures for housing ants, or domatia. However, only some of the domatias are inhabited with ants.

Moving away a fallen tree trunk reveals alarmed workers of the epigaeic Brown Crazy Ants (Anoplolepis longipes) *darting about over a brood of pale-cocooned pupae.*

Numerous epiphytic plants like ferns and orchids have ants inhabiting them. The tangled root systems of these epiphytes are ideal nest sites for ants. The leaf litter, soil and debris carried by the ants for building nests serve as nutrient for the plant. The litter and debris also absorb water and maintain relatively high humidities for the epiphytes to survive. Some other plants which exhibit specialised relationships with ants in Sabah are *Korthalsia* spp. (rattans), *Dinochloa* spp. (climbing bamboos) and *Neonauclea* spp. (trees, or the coffee family of Rubiaceae).

Epigaeic ants. Epigaeic ants (especially the ponerine group) are conspicuous in the virgin forest because the ground vegetation is sparse. Most epigaeic ants build their nests by excavating chambers in the soil, underneath fallen logs or beside the roots of big trees. These ants are often seen scavenging or foraging either solitary (e.g., *Odontomachus, Odontoponera*, *Diacamma*) or in groups (*Leptogenys*, *Pheidole*, *Pheidologeton*). This group of ants feeds on almost anything found on the forest floor, such as fruits, seeds, fallen flowers, the larvae and pupae of insects, dead arthropods and also carcasses of other animals.

Subterranean ants. Subterranean ants are of fairly small size, and this enables them to move easily in the soil. Many of these ants feed on soil organisms. Both epigaeic and subterranean ants play important roles in soil regulation and ventilation. The chambers excavated by these ants loosen up the soil, which allows better penetration by the root systems of plants. Ant nests in the soil affect the soil profile and also nutrient status. In general, ground habitats with a higher density of ant nests will have a higher nutrient status because of the organic matter (e.g., decomposed food, debris, leaf litter and dead ants) concentrated inside the nests.

THE LOWLAND RAINFOREST ANTS

Subfamily ***FORMICINAE***

In general, ants from this group have acid-projecting systems at the apex of the gasters. A pheromone which contains a high concentration of formic acid defence is released when the ant is disturbed. This also serves as a kind of chemical communication to warn their mates of danger ahead. In certain formicine ants (and other subfamilies too), trail pheromones are secreted. It connects the source of food and the ant nest. This will enable the rest of the colony to locate the source of food, so that workers will play their part efficiently in bringing the food back to the nest. This is the reason why some ants move as "organised" trails and do not simply roam around.

Formicine ants do not sting as the sting has been replaced with the acid-projecting system. However, some species do produce painful bites, like the common Weaver Ant, *Oecophylla smaragdina* (known as *kerengga* in Malay). Although this species is widely distributed throughout Malaysia, including the lowlands of Sabah, it is not often or easily seen in virgin mixed dipterocarp forest. *O. smaragdina* is commonly found in open areas, like orchards, housing estates and fringes of forests, and also in secondary forest.

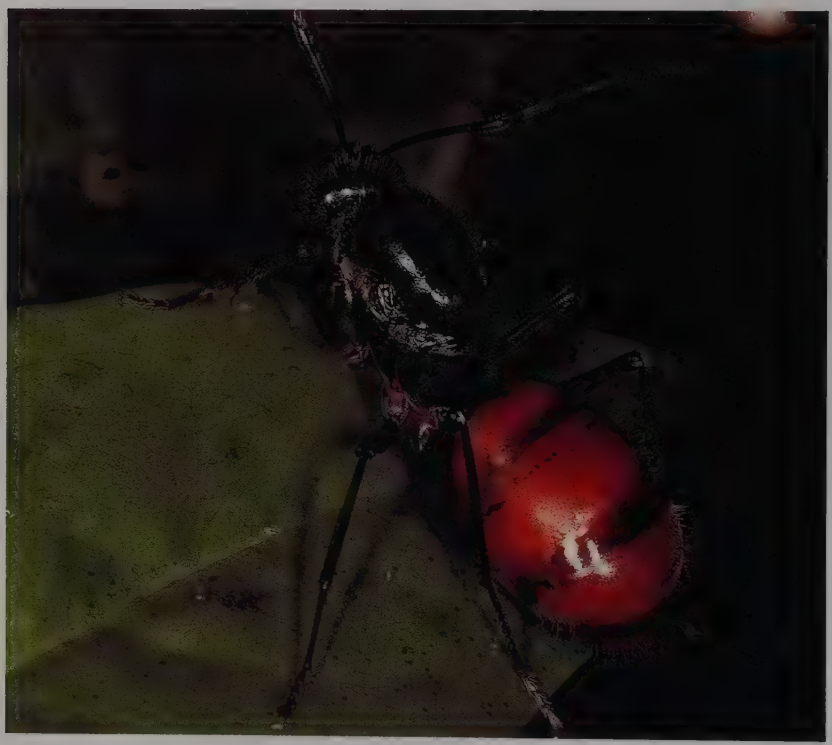
1. THE GIANT FOREST ANT (*Camponotus gigas*)

This is the biggest and most conspicuous ant species in the rain forest. An eminent entomologist, the late Y.P. Tho, once wrote (Nature Malaysiana 6:4):

> *"It is virtually almost impossible for anyone who has roamed or worked within a closed canopy indigenous forest, not to have encountered these ants. Watching them walking all over the forest floor has never failed to evoke a feeling of awe and respect even from the most seasoned naturalists, let alone those who have just been initiated."*

The ant is black in colour except the gaster, which is reddish brown. This species is polymorphic, or represented by distinctive forms. The worker caste can achieve a length of 25 mm, while the soldier caste with an enlarged head (approximately 2.5 times bigger than worker's head) has a length of 30 mm. The queen, which is the largest among all, can be as long as 35 mm. This ant is commonly seen foraging solitarily on the forest floor during the day. However, it is actually an arboreal species and is more active at night. At dusk, they will march up to the canopy to forage for food and all the ants will come back to the nest just before sunrise. Most of the ants remain inactive in the nest during day time except for a few, which roam around on the forest floor.

The nest of this species is found in the soil, at the base of trees and in fallen logs, covered with leaf litter and debris. The Giant Forest Ant is



The queen of the Giant Forest Ant, Camponotus gigas, *its wings shed off after the nuptial flight (photo: C.L. Chan).*

omnivorous. However, some researchers have reported that this ant is a fungus specialist. Unlike the ferocious *kerengga*, this species is less aggressive. It is a shy creature which normally runs away when disturbed, although sometimes releasing formic acid which can be quite irritating. The soldier caste does bite with their formidable mandibles.

C. gigas appears in all respects to be a very highly successful species of the rain forest but yet somehow it has never established itself outside. It is not found in urban, rural and agricultural areas. This nocturnal species has a low tolerance of high temperatures and cannot adapt well to sudden changes of the environment.

The worker ants of *Camponotus gigas.*

2. DRUMMER ANTS
(*Camponotus* spp. of the *Myrmoplatys* subgenus)

Some *Camponotus* species live in the ochrea, or apical extension of the leaf sheath, of rattans. In Sabah, it has been reported that a few species of *Korthalsia* have specialized ochreas forming chambers occupied by ants. The presence of these fierce ants seems to help deter herbivores

When alarmed, Drummer Ants (Myrmoplatys sp.) emerge from their carton nests on a rattan palm, frantically patrolling their territory and drumming their gasters in unison against the plant.

Other species of Camponotus, *such as this, also live within the ochreas of rattans, although they do not "drum".*

such as squirrels, wild pigs and elephants which are fond of eating rattan shoots. In a rattan species, *Korthalsis hispida*, *Camponotus* ants which occupy or nest in the plants produce sound signals by rapping or drumming their gasters against the plant when disturbed.

According to the species, four different functions are served by sound signals in ants: alarm, recruitment, termination of mating by females, and modulation of other communication and forms of behaviour. It has been suggested that the presence of ants may be of adaptive significance to rattans in providing extra protection against herbivores. Circumstantial evidence seems to suggest that rattan plants lacking ants may be preferentially consumed by herbivores well before those with ants. The production sound signals by ants in rattans is widely known in the lowland rain forest. Besides *Camponotus*, this behaviour is also known to be widespread among other arboreal ants such as *Dolichoderus, Hypoclinea* (both Dolichoderinae) and *Polyrhachis* (Formicinae).

3. THE GOLDEN ANTS
(*Polyrhachis ypsilon* and *P. bihamata*)

These ants are called Golden Ants because of the gold-coloured pubescence which covers their entire bodies. They are quite striking in the rain forest and have lengths ranging from 9 to 11 mm. The Golden Ants are harmless but they have spines at the back of the thorax and hooks at the petiole. These structures protect them from being attacked or swallowed by predators, especially birds. The hooks and spines can easily penetrate human skin when the ants are carelessly handle ... and one will have a tough time getting rid of them! These Golden Ants usually stop moving when they are disturbed (e.g., when the branch they are on is being shaken). This is one way in which ants prevent detection by predators.

Golden Ant, Polyrhachis ypsilon.

Polyrhachis ypsilon and *P. bihamata* look superficially alike and it is difficult to tell them apart at a glance. They are about the same size and have nearly the same structure. However, when examined from the anterior or posterior position, the hooks of *P. ypsilon* form a 'U' shape before joining at the petiole. There are also other *Polyrhachis* species which are gold in colour but these two are the prominent ones in the lowland rain forest in Sabah.

Golden Ants can be easily spotted foraging on vegetation (e.g., tree trunks, vines and shrubs). Both species are common, feeding on the extrafloral nectaries of ground plants such *as Eupatorium, Jacquemontia, Merremia* and *Uncaria*, just to name a few. The nests of Golden Ants are mostly arboreal, although occasionally they can be found in dead tree trunks and also in the soil at the base of trees. Sometimes, temporary satelite nests are found underneath leaf litter and debris. At times they can be seen wandering around on the ground.

4. THE SPIKY ANT (*Polyrhachis defensa*)

In general, *Polyrhachis* ants have spines either at the thorax or petiole, or on both structures. *Polyrhachis defensa* is also common in the Danum Valley lowland rain forest of Sabah. The ant is charcoal black in colour, except for the gaster, which is reddish black, and is thus easily distinguished from their congeners, the Golden Ants. A pair of spines is located on the pronotum (the first thoracic segment), propodeum (the first abdominal segment) and petiole. This species does not bite and has the same defense mechanism as the Golden Ants. Many times, it can be seen moving rapidly to the lower side of the leaf when it senses danger.

Like the Golden Ants, this is also an arboreal species. Unlike them, however, this species is always seen foraging solitarily. In rare instances, a large number of these ants can be found on the fruits of cultivated fruit-trees such as *langsat* (*Lansium* sp.). Spiky Ants are common in orchards and their nests have been seen between dried leaves of the banana plant.

As their name suggests, Spiky Ants (Polyrhachis defensa) *are quite distinctive with the three pairs of spines on the body.*

5. THE TRUNCATE-HEAD ANTS (*Camponotus* spp. of the subgenus *Colobopsis*)

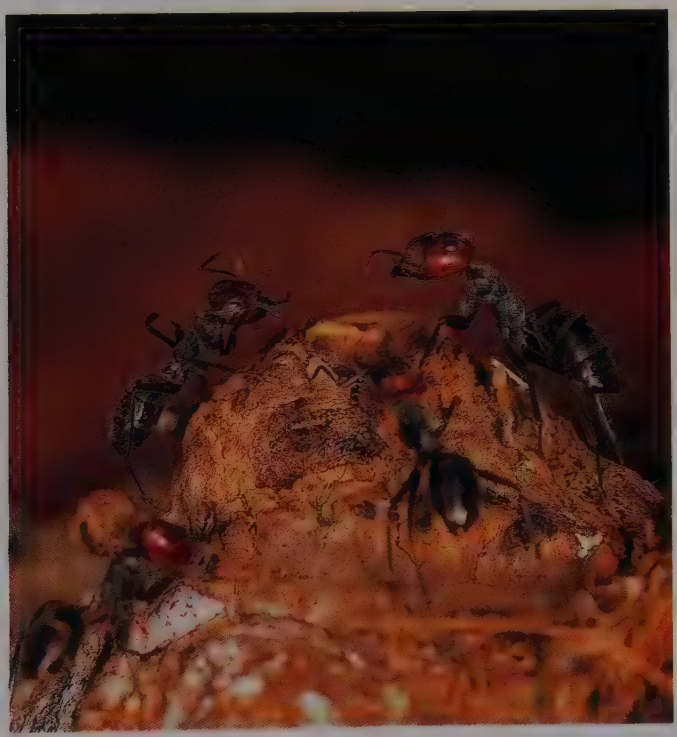
Camponotus species of the *Colobopsis* subgenus (only some 4–5 mm long) are arboreal ants, often seen nesting in the narrow cavities of stems or tree trunks (i.e., they are lignicolous). This is one of the ant genera with species forming mutualistic relationships with plants.

The genus is polymorphic (with distinctive forms) and the soldiers have distinctive truncate heads. These soldiers seldom leave the nest but stand guard at the nest entrances, where they serve literally as living doors. Entrances of the nest are partly sealed with carton. When workers

approach them from either end and give the right signal (presumably a combination of simple touch and colony-recognition scent) the soldiers pull back into the nest to allow their nestmates free passage.

The Truncate-Head Ants are not aggressive or ferocious. The worker ant stands still and lifts its gaster when on alert. When it is motionless, the predator will have difficulty finding it. The lifted gaster is a defensive posture, ready to secrete volatile substances from its apical end.

The truncated head of a Colobopsis *soldier ant.*



Colobopsis *soldiers guard a nest entrance.*

6. CRAZY ANTS
(*Paratrechina longicornis* and *Anoplolepis longipes*)

Paratrechina longicornis (black and 3–4 mm long) is common at the forest fringe. They can also be commonly seen foraging for food in the kitchen or any domestic area where food is stored. They are harmless and run aimlessly when disturbed, hence the name "Crazy Ants". Another species, *Anoplolepis longipes* is also known as Crazy Ants; they are yellowish brown in colour and about the same size as *P. longicornis*. They are common in orchards, and cocoa plantations, and are often found at the forest fringe. In Papua New Guinea, *A. longipes* is used as a biological control agent to control the cocoa pest, *Pantorhytes szentivanyi* (Coleoptera: Curculionidae). The larvae of the pest bore into

Surrounded by numerous workers carrying larvae and pupae, the queen of the Black Crazy Ants (Paratrechina longicornis) *is the nucleus of a mass migration of the colony from a damaged nest.*

the stems and branches of cocoa trees. *A. longipes* attacks the adult of this pest and also eats their eggs.

The nest of *P. longicornis* is normally found in the soil, or underneath leaf litter and debris. During heavy rainfall, colonies of this species are often observed moving out from their nests to dryer and safer places in buildings (e.g., a wall or roof). They move on pheromone trails laid by the scout ants. During these emigrations, the queens walk under their own power, surrounded or escorted by workers, which also carry the brood.

These swift-running Crazy Ants are active day and night. They are very adept at locating food and are often the first to arrive at newly placed food. They seem to have incredible chemical senses and receptors which can detect the source of food within a short time. The ants fill their crops rapidly and hurry to recruit nestmates with trails of pheromone exuded from the apex of their gaster. However, they are also very timid in the presence of competitors. When more aggressive species begin to arrive in force, the *P. longicornis* or *A. longipes* draws back and runs excitedly in search of new unoccupied food sources.

7. THE SAW-TOOTH ANTS (*Myrmoteras* spp.)

These ant species are small (less than 5 mm long) and rarely seen because they forage exclusively in the soil and leaf litter. Most species in this subfamily (Formicinae) are not predatory ants, but *Myrmoteras* spp. are an exception, and appear to specialise on small and soft-bodies soil arthropods (such as collembolans and diplurans).

This subterranean genus has highly specialised predatory trap mandibles which can fold back. When extended, the mandibles are extremely long, slender, linear blades which resemble saws that exceed the head length. The genus is regarded as primitive in many other physical and sociobiological aspects. It is a solitary forager in soil, and each colony is believed to be very small, with less then 30 individuals. The large compound eyes still remain a mystery, as this feature apparently serves no purpose in subterranean species.

The Saw-Tooth Ant, Myrmoteras *sp., uses its menacing long mandibles, which can open widely and close forward, to catch prey.*

Myrmoteras spp. are mostly found in the soil in primary forest, and less commonly in logged forest. This is because the soil in the primary forest is less disturbed and has a higher nutrient status, and is more suitable for subterranean ants.

8. KERENGGA (WEAVER ANTS) *(Oecophylla smaragdina)*

Oecophylla smaragdina or the Weaver Ant is one of the most common and conspicuous species in Southeast Asia. They are seen at the fringes of lowland forests, although occasionally they are also found inside the forest. These ants are relatively large, with bodies ranging up to 8 mm in

length, and exclusively arboreal. The workers are orange or rusty red in colour while the queens are green (an unusual colour among ants) and the males black. *O. smaragdina* does not sting but produces painful bites with its sharp and powerful mandibles, intensified by irritating secretions from the mandibular glands. It also releases formic acid from the gaster which can cause irritation to human skin.

The nest construction of Weaver Ants involves a very unique procedure. The workers pull the leaves together and then bind them into place with thousands of strands of silk from the silk-glands of the larvae. Originally, the silk is produced to enable ants to make cocoon when they pupate; however no Weaver Ant larvae ever makes a cocoon! The workers bring nearly mature larvae to the building sites and employ them as living spindles, moving them back and forth as they expel threads of silk from their labial glands.

The construction of communal silk nests has clearly contributed to the success of *Oecophylla*. This has helped the Weaver Ant to become among the most abundant and successful social insects of the Old World

Weaver Ants, Oecophylla smaragdina, *tend a nest of living twigs and leaves held together by larval silk.*

tropics. Two species of *Oecophylla* are known. *O. smaragdina* occurs from India to Queensland, Australia, and the Solomon Islands, while a closely related species, *O. longinoda*, occurs in most of the forested portions of tropical Africa.

Although *O. smaragdina* is agressive and ferocious, it contributes much to agriculture. Since the twelfth century, *O. smaragdina* has been used to control the citrus pest in southern China. *O. smaragdina* also protects mango fruits and coconuts from being attacked by pests. This species also has potential use as a biological control agent against cocoa pests.

Fair exchange: Weaver Ants sequestrate energy-rich "honey dew" excreted by the nymphs of sap-sucking bugs (Homoptera), which are protected from predators through the presence of the ants.

Caterpillars of some lycaenid and riodinid butterflies are tended by ants, as is the green caterpillar here by Weaver Ants, but those of some other butterflies can also fall prey to ants.

In terms of both species and individuals, the Myrmicinae is easily the most diversified and abundant of all ant subfamilies in the rain forest of Sabah. With conventional pitfall traps (which collect mainly terrestrial ants) to study epigaeic ants in Sabah's Danum Valley lowland forest, the Myrmicinae represented more than 40% of the species and approximately 85% of the individuals collected.

The abundance of this subfamily is extremely high because of the presence of large-colony species (e.g., *Pheidole* spp. and *Pheidologeton* spp.). A single baited pitfall trap can easily fill up with 3000–5000 individuals of these species at one time.

Although myrmicine ants are dominant in the rain forest, they are not so conspicuous when compared to formicine and ponerine ants because they are generally small (less than 5 mm long). Furthermore, most of the large-colony myrmicine species are epigaeic, foraging in the leaf litter on the ground where their coloration is quite cryptic. It is not so easy to detect myrmicine ants foraging on the ground. However, there are also some arboreal myrmicine species which are common in the logged forest, e.g., *Crematogaster* spp., which are noticeable.

1. THE HEART-GASTER ANTS (*Crematogaster* spp.)

This arboreal genus can be recognised through its gaster which is heart-shaped in outline attached dorsally to the post-petiole. Most species in the rain forest are 3–4 mm in length, ranging from brown to dark brown in colour. There are some smaller yellowish species (less than 2 mm long) which can be found on the vegetation and also in the soil. This is the genus well known for species which form ant-plant relationships. In Sabah's lowland forests, these ants can be found in the hollow internodes of pioneer trees such as *Macaranga hypoleuca*, *M. winkleri*, *M. pearsonii* and *M. indistincata*. Some *Crematogaster* species also

make carton nests (with a lot of chambers within) on tree branches and the lower side of leaves on different tree species in the forest.

Some *Crematogaster* ants bite but this is not as painful as the bites of the ponerines or some aggressive formicines. Most of these ants release alarm pheromones which contain alcohols, aldehydes and other volatile substances from various glands in the ant body. One of the most fascinating *Crematogaster* species is *C. inflata,* black in colour, which has a striking yellow patch on the back of the metanotum (the third thoracic segment) which contains hypertrophied (or much enlarged) metapleural glands. These glands produce white-sticky secretions which serve primarily as an alarm and repellent substance.

Heart-shaped gasters are characteristic of Crematogaster *ants, which are also called "semut tonggek" in Malay, in reference to the alarm response of lifting their gasters to an erect posture.*

Perhaps ominous as a signal to likely predators, the bright yellow metapleural glands of Crematogaster inflata*, looking like miniature life jackets around its thorax, can secrete defensive fluids when the ants are disturbed. It is not known how these fluids function, but they may immobilise some predators.*

2. HARVESTING ANTS (*Pheidole* spp.)

Pheidole (2–3 mm long) is one the granivorous genera that regularly uses seeds as part of their diet. Harvesting ants are dominant elements in the deserts and drier grasslands in warm temperate and tropical regions around the world. Seed-harvesting species compose more than half of all ant colonies in some Australian localities. In the Namib Desert, they make up more than 95% of the total forager biomass. In the rain forest in Sabah's Danum Valley, *Pheidole* spp. comprised more than half of the number of ants collected in one survey, using baited pitfall traps.

This group of ants forages predominantly on the ground in large colonies. The soldier caste has massive, blunt-edged mandibles which are used mainly for crushing hard seeds. However, it is believed that the rainforest *Pheidole* spp. do not feed on seeds alone (i.e., they are not obligate granivores) because these ants have been seen carrying arthropods and carcasses back to their nests on many occasions.

Three castes of the Harvesting Ant, Pheidole *sp.: the largest shown is the queen, with an elongate gaster; soldiers have enlarged heads, and the smallest are workers.*

3. SUBTERRANEAN TRIANGULAR-HEADED ANTS (*Strumigenys* spp.)

Strumigenys is widely distributed throughout the world. Species in this genus which forages exclusively in the soil are very small ants (less than 2 mm long). They belong to the dacetine tribe where the heads are typically triangular-shaped, with a concave vertex (crown of the head) and each antenna has six of fewer segments (*Strumigenys* has six-segmented antennas).

It is believed that most *Strumigenys* spp. are predatory ants feeding on collembolans and other soft-bodied arthropods. There are fungus-like growths on the waist and other parts of the body, possibly containing substances that lure the soil arthropods as prey. Like the formicine *Myrmoteras* spp., *Strumigenys* includes species that have relatively long primitive-type mandibles which exert a violent trap-like action to secure prey. If the collembolan prey is relatively small in comparison to the *Strumigenys*, the ant lifts it off the ground and may sting it to render it immobile. This brown-bodied ant has small hairy bristles that allow soil particles to stick onto its body, providing a good camouflage.

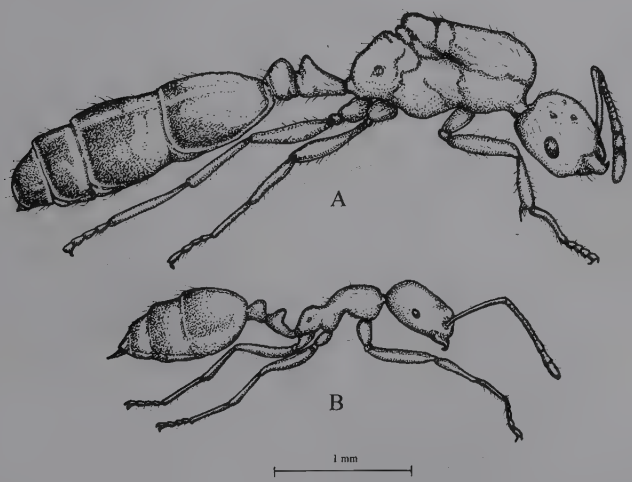
The Triangular-Headed Ant, Strumigenys *sp.*

4. THE PHARAOH'S ANTS
(*Monomorium pharaonis*)

These small brown myrmicine ants (only 2 mm long) are known to be worldwide household pests. Like the Crazy Ants, *Paratrechina longicornis* & *Anoplolepis longipes*, this is a common species in premises near the forest edge. In the Field Studies Centre in Sabah's Danum Valley, for example, colonies of multi-queened *Monomorium pharaonis* invade buildings to occupy cracks in the walls, the linings of instrument cases, and spaces in piles of discarded clothing and between leaves of books, and other similarly unlikely microhabitats.

Colonies of this species are characterised by extreme agility—a readiness to move when only slightly disturbed and an ability to swiftly discover new sites and organise emigrations. This species is well adapted to almost any environment, as they can be found in cold and damp places like the forest floor and also dry and fairly warm places.

The Pharaoh's ants produce nasty bites which are quite irritating although the pain does not last as long as that of ponerine ants. They are sometimes found "hiding" singly among clothes, blankets, and bedsheets, and will attack when they are disturbed.



Queen (A) and worker (B) of the Pharaoh's Ant, Monomorium pharaonis.

5. MARAUDER ANTS (*Pheidologeton diversus*)

The Marauder Ants are highly polymorphic (i.e., with highly distinct forms). It has been reported that the minor worker has a head width about 1/10 that of the major worker (soldier caste) and a dry weight only about 1/500 that of the larger ant. The length of the minor worker is less than 2 mm and that of the soldier is more than 6 mm. There are also a lot of workers which are varied in size.

These ants look very much like *Pheidole* at one glance. However, this species is darker in colour and the soldier caste has an extremely enlarged head, compared to *Pheidole*. Moreover, the antenna of worker ants of *P. diversus* has a two-segmented club, compared to the three-segmented club of *Pheidole*. The club is the apical end of an antenna comprising one or more enlarged segments.

Marauder Ants are so called because of their raiding behaviour which is similar to those of the army ants. The colonies are huge, with a single oversized queen and hundreds of thousands of workers. The foragers travel on one or two stable trunk trails that extend from 5 to over 100 metres from the nest, back and forth, day and night. A *P. diversus* raid begins when ants move away as a group from the trunk trail. Ant researchers have reported that they form a narrow column that grows outward, like the protrusion of an amoeba cell, at the rate of 10–20 cm a minute.

Marauder Ants are able to overpower exceptionally large and formidable prey, including frogs and toads, by overwhelming them with sheer force of numbers. They also carry large objects back to the nest rapidly with well coordinated groups of foragers acting independently.

The Marauder Ant, Pheidologeton diversus, *excavating flesh from a dead toad. Soldiers, with enlarged heads, have formidable mandibles that tear and cut the bulk food into smaller pieces to be brought away to the nest by workers. Minor workers are often seen on the heads of soldiers, presumably protecting them from parasitic flies, which easily spot the big and clumsy soldiers and hover overhead, waiting to lay eggs on the ant's body.*

Most ponerine ants are monomorphic, i.e., with one typical body form. Several common ponerine ants are often seen foraging solitarily on the forest floor. They are quite noticeable compared to myrmicine ants because of their fairly large body size (8–12 mm long), e.g., *Odontomachus*, *Odontoponera* and *Diacamma*. There are also some smaller ponerine ants (less than 2 mm long) that forage in the soil and leaf litter, such as *Hypoponera*, *Mystrium* and *Discothyrea*. Many of the ponerine ants are specialist predators of certain invertebrates, and only occur in small colonies of less than 100 workers.

Ponerine ants have a strong influence on the soil profile as most of them nest and forage on or in the soil. Many have cylindrical bodies which probably help them to "worm" their way through the soil and litter. Indirectly, the loosened soil and excavated chambers will provide better aeration for plant root systems.

Most of the bigger ponerine ants inflict powerful stings that cause a burning sensation and itchiness that can last for a couple of days. Unlike that of bees, the sting of a ponerine ant will not stick to the skin and is still able to function as before. The sting is an important defence for this group of ants, and is also used to immobilise prey.

1. THE LONG-JAW ANTS (*Odontomachus* spp.)

Ants of this genus have long and linear mandibles inserted in the middle of the anterior margin of the head, each with an apical armament of 2–3 teeth arranged in a vertical series. These elongated mandibles snap shut convulsively, impaling the enemy with the sharp teeth on their edges. When these ants are put into vials containing 75% ethanol solution, the aggressive movement of the mandibles often causes some "clicking" sound. At the same time, their gasters are incurved ventrally with the stings projecting towards the anterior part of the ants; they are trying to sting anything that comes into contact. This aggressive posture of the gaster is common among the ponerines when they are caught by predators.

Powerful muscles controlling the mandibles of the Long-Jaw Ant, Odontomachus rixosus, *are used to manipulate rapid motions of the jaw.*

Odontomachus spp. are usually dark brown in colour. *O. rixosus* is a common species on the forest floor in Sabah's lowlands. The legs and antennas of this species are yellowish brown.

2. SCAVENGER OR HUNTER ANTS
(*Diacamma rugosum* and *Odontoponera transversa*)

These two genera are known as Scavenger or Hunter Ants because they are conspicuous predatory ants which often roam solitarily on the forest floor. They are not only common in the rain forest but also found in almost all habitats (with the exception of domestic habitats) in this region.

O. transversa has been reported to be more active during the day, whereas *D. rugosum* is active both day and night. The prey, usually caught with their powerful mandibles, is then stung and rendered immobile.

Both species are black in colour and have striations on their bodies. *D. rugosum* has a unique petiole structure with the node armed dorsally with a pair of spines. In *O. transversa*, the node of the petiole is simpler, with short spines on the pronotum of the thorax. The anterior clypeal margin of *O. transversa* is armed with 7–9 blunt teeth.

The Scavenger or Hunter Ant, Diacamma rugosum *(left) and* Odontoponera transversa.

The organisation of *D. rugosum* is rather unique and different from other ant species. This species has "ergatoid" queens, which have normal female genitalia but a worker-like body. Thus, they are not likely to engage in ordinary nuptial swarms.

Although both genera forage predominantly on the ground, *D. rugosum* is sometimes seen foraging on the lower or ground vegetation of the forest. In southern India, *D. rugosum* has been reported to have a peculiar method of obtaining water, where workers decorate the entrances of their nests with relatively hygroscopic objects such as dead ants and bird feathers. In the early morning, light dew forms on these objects, which serve as water traps, and is subsequently collected by the ants. During dry season, the droplets of dew appear to be the only external source of water available to the ants. However, this method of sequestrating water is not obvious in Sabah forests, as the humidity in the rain forest is higher.

3. THE DANUM FIRE ANTS (*Leptogenys* sp.)

This is one of the most irritating species because they bite and sting any intruders which pass or step on their swarming trails. Hundreds or sometimes thousands of this species are seen travelling on one or a few trunk trails linking to a source of food. They also visit buildings and feed on leftover food like bones and meat. The sting and bite are painful. Because of numerous attacks on unsuspecting human victims by this species at the Field Studies Centre in Sabah's Danum Valley, they are given the appropriate name, "Danum Fire Ants".

Ponerines which have pectinate (comb-shaped) claws are classified as *Leptogenys*. The Danum Fire Ants have large colonies, unlike other *Leptogenys* species which normally have colonies of less than 100 workers. Because of their small numbers and foraging in groups, they are also known as the Scout Ants. Sometimes they are also known as the Migrating Ants because they migrate from one place to another, often in one short period.

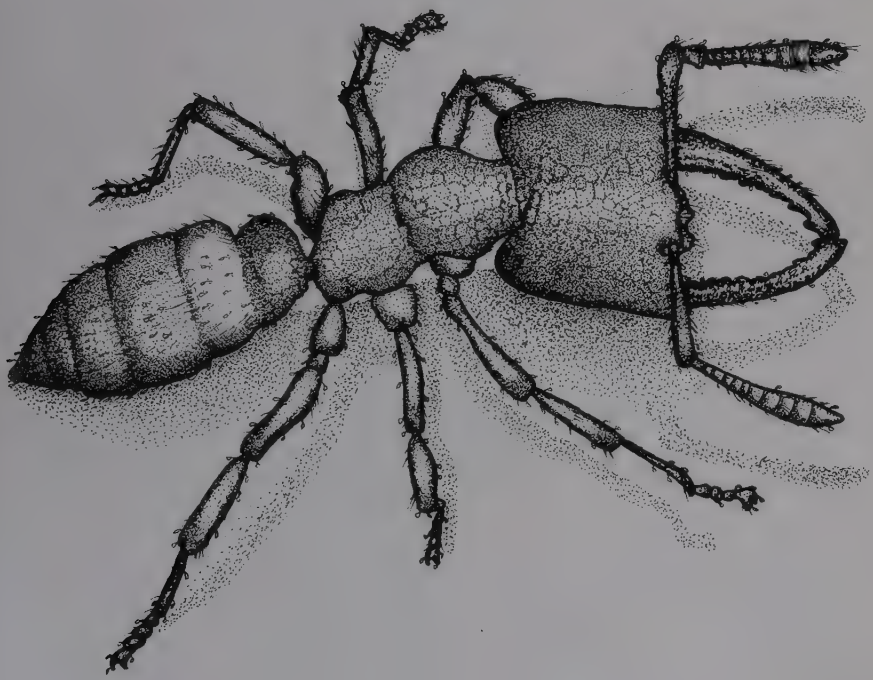
Fire Ants (Leptogenys *sp.*) *swarm upon the dead body of a cricket.*

4. THE BULLDOZER ANT (*Mystrium* sp.)

These are not robust or large ants as their common name may imply. They are so called simply because of their almost square heads with blunt mandibles, which look very much like miniature bulldozers. This is actually a timid and small (only 4-mm-long) ponerine species, always found in the soil and leaf litter. They are slow-moving ants which are sensitive to light. Their stings are too small to penetrate human skin. On their heads, there are spatulate (spoon-shaped) hairs which collect soil particles and which may thus increase the camouflage.

The mandibles of this species are twisted, asymmetrical, and arranged so that their flat inner surfaces press against each other as the abductor muscles contract. When the muscles pull strongly enough, the mandibles

slip past each other with a convulsive snap. If the mandibles strike a prey (usually a small arthropod), a stunning blow is delivered.



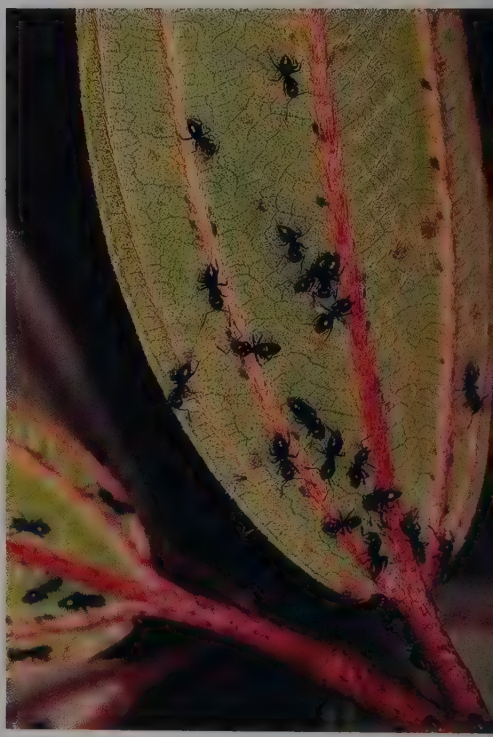
Bulldozer Ant (drawn by M. Allai).

DOLICHODERINE ANTS

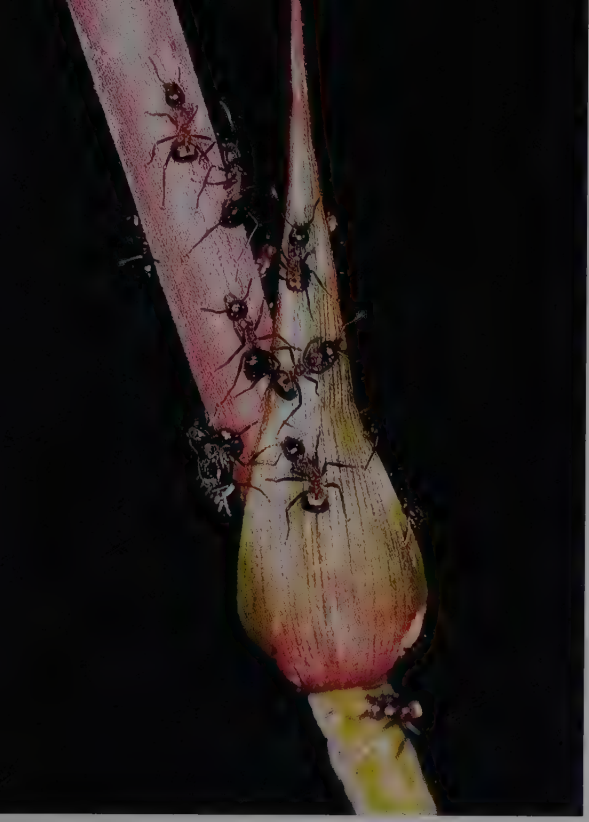
The Dolichoderinae, mostly arboreal in habit, is represented by relatively few genera in Sabah's lowland forests. For instance, three genera (*Dolichoderus, Technomyrmex* and *Tapinoma*) including a number of species are commonly seen at the Danum Valley research site.

Dolichoderus (with a body 4–5 mm long) is a genus with a prominent and rounded, or spiny propodeum (first segment of the abdomen), whereas *Technomyrmex* and *Tapinoma* are characteristically without any prominent node on the petiole, and are smaller (less than 2 mm long). In dorsal view, *Technomyrmex* has all five gastral segments visible whereas in *Tapinoma*, only four of the five gastral segments can be seen. They are always found on vegetation, feeding on extrafloral nectaries and food bodies.

Dolichoderus exhibits mutualistic relationships with plants. In Malaysia, the Cocoa Black Ants, *D. thoracicus*, are used as a biological control agent against the stinging bug (*Helopeltis theobromae*) which stings the young cocoa pods. When *D. thoracicus* are found on the pods, the pest will not approach. The ants are believed to secrete volatile phenolic substances which ward off the pest. *D. thoracicus* is also found in the lowland rain forest in Sabah.



Some small black *Technomyrmex* ants are tending tiny sap-sucking homopterans at the under surface of a *Melastoma* leaf.



These dolichoderine ants are feeding on secretions from the shoot of a climbing bamboo *Dinochloa* sp.

Subfamily ***DORYLINAE***

THE ASIAN ARMY ANTS

Aenictus is one of the genera from this subfamily recorded in Sabah's lowland forests. Bolton, in his latest publication "Identification Guide to the Ant Genera of the World", classified *Aenictus* in the Aenictinae subfamily. He divided the Dorylinae group into six subfaimilies. An argument, however, can be made for unifying all these subfamilies in the doryline section, as they exhibit a high number of similar characters which together could constitute a single subfamily diagnosis. In fact, only two genera from the Dorylinae subfamily are recorded in the Oriental region, the other genus being the African Driver Ant, *Dorylus*. *Aenictus* is also known as the Asian Army Ant as it has a lot of similarities, in terms of foraging behaviour, with the infamous

Neotropical Army Ant, *Eciton brucelli*. However, the Asian Army Ants seem to be less ferocious although they do attack and invade other ant colonies within a short time.

Aenictus is known even to attack colonies of larger ants in the forest, such as the Scavenger Ant *Diacamma rugosum*. Because of their massive population (an *Aenictus* colony can have 50,000–100,000 individuals), the ponerine species, although larger, is not capable of fighting the Army Ants. Many *Aenictus* individuals attack one ponerine ant, pulling its antennas and legs apart. Within minutes, the whole *Diacamma* nest can be invaded and its former tenants taken as food.

Some Army Ants have been reported to emigrate as often as once a day during the nomadic part of their brood cycle, when larvae are present and raiding for insect prey is most intense. They cluster in sheltered places on the ground surface during the migratory phase. Besides ants, *Aenictus* also feeds on social wasps, termites and a few other arthropods.

(opposite)
A colony of the Asian Army Ant, Aenictus *sp. raids a ponerine species,* Diacamma rugosum. *In the background, a procession of hundreds of thousands of workers march on, invading almost any living creature that they come across. A* D. rugosum *ant is shown being attacked, in the foreground, its antennas and legs pulled apart by the ferocious Army Ants. Some of the ponerine ants escape by running swiftly up nearby plants.*

Subfamily ***PSEUDOMYRMECINAE***

TETRAPONERINE ANTS

Only one genus in this subfamily, *Tetraponera*, is found in the Oriental region. Although present, it is not a common ant in Sabah's forests. For example, only one species has been documented in the large lowland forest area in Sabah's Danum Valley. This arboreal species is black in colour, and seems to be quite harmless.

A rainforest Tetraponera *species.*

On the other hand, many people will agree that the sting of the *Tetraponera* is exceedingly painful and is felt for several hours. Another species, *T. rufonigra*, also known to many in West Malaysia as the Fire Ant, is mainly found nesting on shade trees (e.g., *Gliricidia*) in cocoa plantations and orchards, and also on roadside trees. In Zaire, this ant genus is feared by the natives, who try to avoid the unpleasant task of cutting the small *Barteria* shrubs scattered through the forest. As a consequence, individual *Barteria fistulosa* plants are often found standing by themselves in the centre of clearing or near the sides of forest paths.

Tetraponera has an elongated and slender body which is rather different from that of a normal ant. It also has large compound eyes. The ant-jumping-mimicking spider appears to mimic *Tetraponera*, and has a long and slender body which resembles that of the ant. With its forelegs lifted up to mimic antennas, it is quite difficult to tell this spider from a *Tetraponera*, which even a potential predator of spiders may dread.

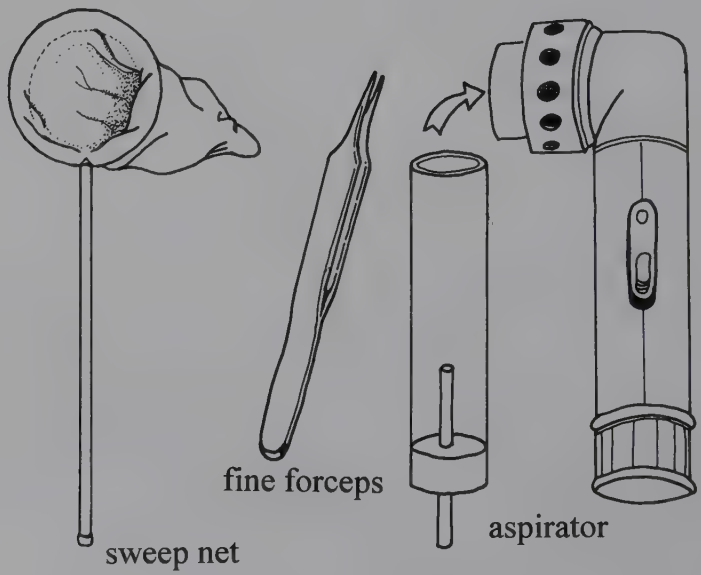
COLLECTING ANTS IN THE FIELD

Collecting ants is simple and straightforward. There are various methods for collecting ants in the field, based on the different levels of ant habitat in the rain forest:

arboreal ants	–	manual collection, fogging, baited pitfall traps.
epigaeic ants	–	baited pitfall traps, manual collections.
subterranean ants	–	Winkler's method, Berlese Funnel.

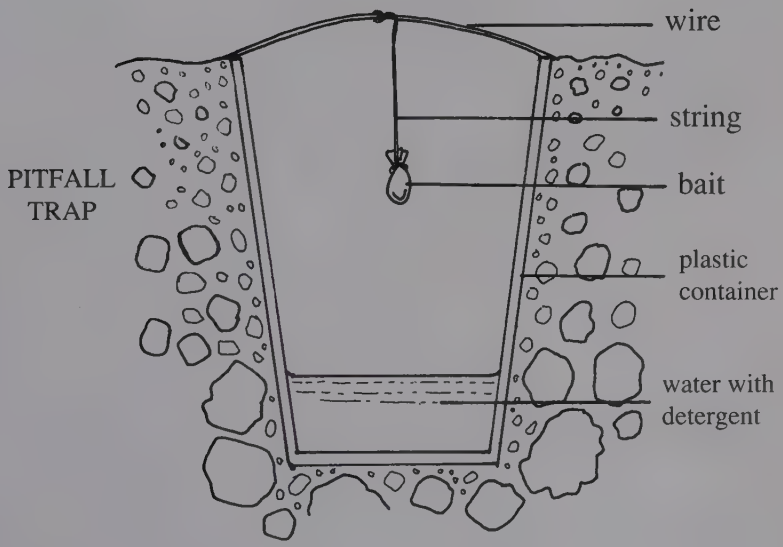
Manual collection

Fine forceps, an aspirator and sweep net are used to collect ants manually.



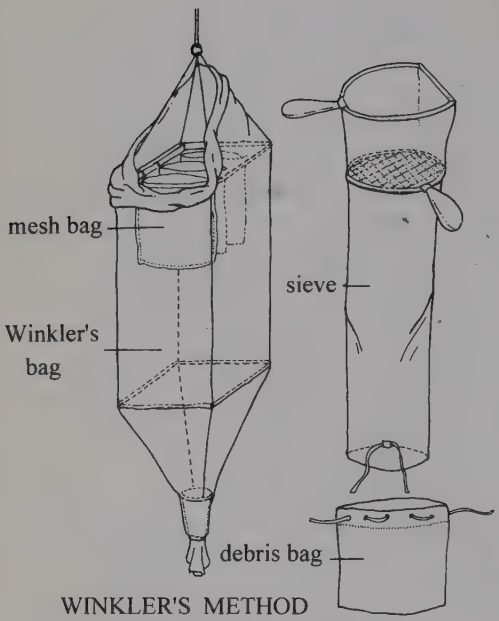
Pitfall traps

The pitfall traps (plastic drinking glasses), with a diameter of 7 cm and a 12 cm depth, can be installed in the ground and left overnight. The traps can be baited with tuna flakes in oil to attract ants. The bait is tied to twigs which are put across the traps. The pitfall traps are filled with some water, and a dash of detergent is added to reduce surface tension. Ants that are trapped in the pitfall traps are collected the next day. This method can also be used for collecting nocturnal ants.

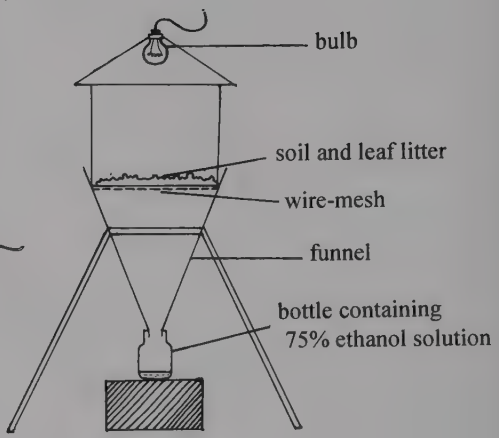


Winkler's method

In Winkler's method, leaf litter and soil (to about 5 cm deep) are sifted, and placed in a debrii bag. This is then placed into several flat mesh bags, and hung inside a larger cloth sack (Winkler's bag). Soil organisms work their way out of the litter and drop into a container placed at the base of the Winkler's bag.



WINKLER'S METHOD



BERLESE FUNNEL

The Berlese Funnel

Soil, leaf litter and debris which are taken from the forest floor are put inside plastic bags. At the laboratory, they are transferred onto a wire-mesh in the Berlese Funnel. The Berlese Funnel is made of zinc or aluminium. Due to heat from the light-bulb, the subterranean ants move downwards, away from the light, and eventually fall into the killing bottle at the bottom, which contains 75% ethanol.

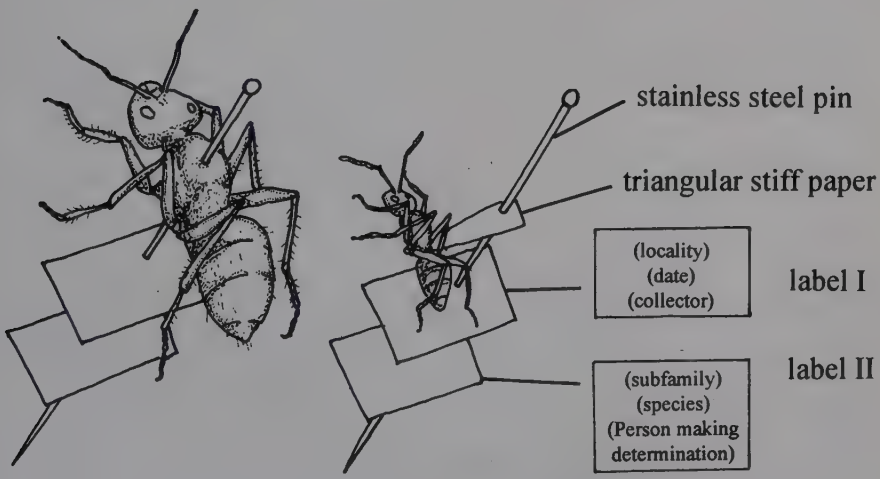
Fogging

Perhaps this is the most efficient method, although costing more than other methods, to collect arboreal or canopy ants in the rain forest as they occur high up. However, this method will kill other insects besides ants.

PRESERVING ANTS

Specimens are preserved in 75% ethanol solution in coded vials. Ants can be stored indefinitely in ethanol-solution, but it is best to prepare some specimens dried and pinned, for convenient reference work.

The standard method for preparing dried specimens is to glue each ant on the tip of a thin triangle of white, stiff paper. As described by Hölldobler & Wilson (1990): "The tip should approach the right side of the ant and touch its ventral body surface. The droplet of glue should be small enough and placed so as not to obscure any part of the body, except a portion of ventral surface. Prior to this procedure, an insect pin should be inserted through the broad ends of the paper triangle. A rectangular label with the locality data goes beneath the mounted ants. Another rectangular label with identification data is put beneath the locality data label. In the case of very large ants, it is sometimes best to simply pass the insect pin directly through the centre of the thorax."



Method for preparing dried specimens of big ants (around 12 mm or longer; left side) and smaller ants.

Mounted specimens are put in the oven (35–40°C) for a few days (depending on the size of the ants) before they are properly kept in the collection box. Crushed naphthalene is normally put in the collection box to prevent ants and other small insects from eating the specimens.

FURTHER READING

Andersen, A.N. 1991. ***The ants of Southern Australia—a guide to the Bassian fauna.*** CSIRO: Australia.

This is a guide on the general biology and community ecology of Australian ants, with an extensive bibliography and many taxonomic keys. The account focuses on ants of the southern and eastern Victoria region.

Bolton, B. 1994. ***Identification guide to the ant genera of the world.*** Harvard University Press: Cambridge, Massachusetts, U.S.A.

An updated and exhaustively expanded revision of the ant taxonomy keys with over 500 scanning electron microscopic photographs.

Brian, M.V. 1983. ***Social insects.*** Chapman and Hall: London.

An account of the social organisation and behaviour of insects which includes bees, termites and ants.

Hölldobler, B. & Wilson, E.O. 1990. ***The Ants.*** The Belknap Press of Harvard University Press: Cambridge, Massachusetts, U.S.A.

A detailed and full account dealing with 292 ant genera with taxonomic keys, including an interesting review of the evolution of social behaviour in ants.

Hölldobler, B. & Wilson, E.O. 1994. ***Journey of the Ants—a story of scientific exploration.*** The Belknap Press of Harvard University Press: Cambridge, Massachusetts, U.S.A.

Richly illustrated and delightfully written, it combines autobiography and scientific lore to convey the excitement and pleasure the study of ants can offer.

Sudd, J.H. 1967. ***An introduction to the behaviour of ants.*** Edward Arnold: London.

This account introduces the many fascinating aspects of ant organisation and behaviour.

Taylor, R.W. 1991. **Formicidae.** in ***The insects of Australia.*** CSIRO, Melbourne University Press: Australia.

A comprehensive entomology textbook for students and research workers, which includes the biology and classification of other insects besides ants.

INDEX TO ANT NAMES

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